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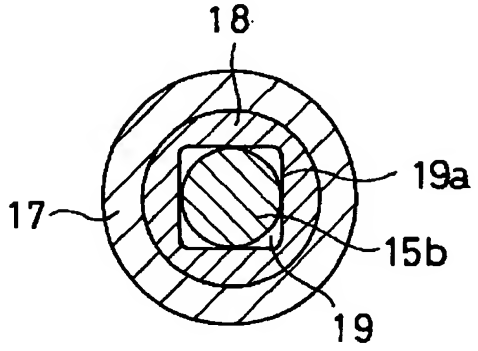
(54)【発明の名称】　電動歯ブラシ等に使用される軸受構造

(57)【要約】

【目的】本発明の目的は、モータを駆動する電源の消費電力を少なくできるようにした電動歯ブラシ等に使用される軸受構造を得ることにある。

【構成】モータ６の動力により往復動される駆動軸１５を支持するすべり軸受１８の軸受孔１９、またはこの軸受孔１９に嵌合される前記駆動軸１５の中間部分１５ｂの少なくとも一方の軸直角方向の断面形状を、非円形にするとともに、前記すべり軸受１８の前記軸受孔１９を作る軸受面１９ａと前記駆動軸１５の孔嵌合部分１５ｂとを周方向の数箇所で接触させた。



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【特許請求の範囲】

【請求項１】　軸方向または周方向に往復動される可動軸をすべり軸受で支持してなり電動歯ブラシ等に使用される軸受構造において、前記すべり軸受の軸受孔またはこの軸受孔に嵌合される前記可動軸の孔嵌合部分の少なくとも一方の軸直角方向の断面形状を非円形にするとともに、前記すべり軸受の前記軸受孔を作る軸受面と前記可動軸の孔嵌合部分とを周方向の数箇所で接触させたことを特徴とする電動歯ブラシ等に使用される軸受構造。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、歯部を磨くための電動歯ブラシ等に使用され、その消費電力を少なくできるようにした軸受構造に関する。

【０００２】

【従来の技術】電動歯ブラシは、筒状の本体ケースに動力源としてのモータおよびこの動力を受けて動作する駆動機構を内蔵するとともに、本体ケースの上端から突出された駆動軸に歯ブラシを着脱可能に取付けて、前記駆動機構により駆動軸とともに歯ブラシを高速度で軸方向に往復直線運動または周方向に往復回動運動させて、歯磨きに使用するものである。

【０００３】以上のようにモータの動力で往復動される駆動軸（可動軸）は、その１～２か所をすべり軸受で支持されている。そして、従来において、すべり軸受の軸受孔の軸直角方向の断面は円形であるとともに、この軸受孔に嵌合する駆動軸の軸直角方向の断面も円形をなしており、駆動軸はその外周面をすべり軸受の軸受孔をなす軸受面に摺接させながら往復動されるものであった。

【０００４】

【発明が解決しようとする課題】前記のような従来の軸受構造では、駆動軸と軸受の軸受面との接触面積が大きいから、駆動軸の摺動抵抗が大きく、それに伴い消費電力が大きいという問題があった。そのため、モータの電源が乾電池である場合には、その電池寿命が短い。ちなみに、単３形アルカリ電池を電源とした従来の電動歯ブラシ（ただし、駆動軸はステンレス製、すべり軸受がポリアセタール樹脂であって、駆動軸が直線往復動するもの）に、歯ブラシを装着しこれに300ｇの負荷を掛けた状態で連続運転した時の、運転時間に対する電池電圧の変化を測定した結果は、図５中Ａに示され、軸受構造での負荷が大きいために使用開始時点での電池電圧が 1.2Ｖと小さく、実使用可能電圧（その電池電圧は 0.9Ｖであって、それ以下では駆動軸に対し適正な駆動力を与えられない電圧）に、約２５分の短い時間で達することが分かった。本発明の目的は、動力源を駆動する電源の消費電力を少なくできるようにした電動歯ブラシ等に使用される軸受構造を得ることにある。

【０００５】

【課題を解決するための手段】前記目的を達成するため

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に、本発明の電動歯ブラシ等に使用される軸受構造は、動力源の動力により軸方向または周方向に往復動される可動軸を支持するすべり軸受の軸受孔、またはこの軸受孔に嵌合される前記可動軸の孔嵌合部分の少なくとも一方の軸直角方向の断面形状を、非円形にするとともに、前記すべり軸受の前記軸受孔を作る軸受面と前記可動軸の孔嵌合部分とを周方向の数箇所で接触させたものである。

【０００６】

【作用】上記の構成によれば、すべり軸受の軸受孔または可動軸の孔嵌合部分の少なくとも一方の断面形状を非円形としたから、すべり軸受の軸受面と前記孔嵌合部分とは周方向の数箇所で接触する。そのため、軸受孔に対する可動軸の嵌合精度が損なわれることがないとともに、軸受孔と可動軸との接触面積が小さくなって可動軸の摺動抵抗を少なくできる。

【０００７】

【実施例】以下、図１～図５を参照して本発明の第１実施例を説明する。

【０００８】図２中符号１は手でしっかりと握れる太さと長さを有した筒状をなす樹脂製の本体ケースで、その下端開口は着脱可能に螺合された蓋２で閉じられている。この本体ケース１には駆動機構３が内蔵されているとともに、この機構３の電源となる電池４が収納されている。電池４には乾電池または蓄電池が用いられ、この実施例は前記蓋２の開閉を伴って出し入れされる乾電池を用いた場合である。また、図２中符号５は電池押しばねを示している。

【０００９】駆動機構３は図２および図３に示すように構成されている。つまり、符号６は電池５の電力が印加されることにより動作される動力源としてのモータで、その出力軸には駆動歯車７が取付けられている。この歯車７には中間歯車８が噛み合わされ、この歯車８には中間平歯車９が固定されている。中間平歯車９には従動平歯車１０が噛み合わされている。図２～図４中符号１１，１２は夫々歯車軸で、歯車軸１１は前記歯車８，９を支持し、歯車軸１２は前記歯車１０を支持している。これらの歯車軸１１，１２は本体ケース１の内面に固定された歯車ベース１３に支持されている。さらに、従動平歯車１０にはその中心から偏心した位置に駆動ピン１４が突設されている。

【００１０】この駆動機構３には可動軸としての駆動軸１５が駆動ピン１４に連動するように取付けられている。つまり、例えばステンレス製の駆動軸１５にはその軸直角方向に沿って横長な係合溝１６が設けられ、この溝１６に駆動ピン１４が挿入して係合されている。駆動軸１５は本体ケース１の上端部に形成された筒状の軸受支持部１７を貫通して本体ケース１の上端から突出されている。この駆動軸１５の本体ケース１の外に突出された先端部には軸直角方向の断面が四角な角軸部１５ａが

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形成されている。前記係合溝６を設けた下端部および上端の角軸部１５ａを除いた駆動軸１５の中間部分１５ｂは、図１に示すように断面円形の丸棒で形成されている。

【００１１】前記軸受支持部１７にはすべり軸受１８が内蔵されており、この軸受１８に駆動軸１５が貫通されている。すべり軸受１８はポリアセタール樹脂の一体成形品であって、図１に示すように中央部に上下両端が夫々開放された軸受孔１９を有している。この軸受孔１９はその軸直角方向に沿う断面を非円形例えば略四角形状にして形成されている。そして、この軸受孔１９には駆動軸１５の断面円形をなす中間部分（つまり孔嵌合部分）１５ｂが嵌合されている。そのため、軸受孔１９を作るすべり軸受１８の軸受面１９ａに、前記中間部分１５ｂの周面の４か所を接触させて、駆動軸１５がすべり軸受１８に摺動自在に支持されている。

【００１２】図２に示すように駆動軸１５の角軸部１５ａには、歯ブラシ２０が着脱可能に取付けられている。歯ブラシ２０は柄２１の先端部にブラシ毛２２を植毛するとともに、柄２１の基端部２１ａに角軸部１５ａの先端部に着脱可能に嵌合される孔などからなる嵌合部２１ｂを設けて形成されている。嵌合部２１ｂと角軸部１５ｂａとの嵌合により歯ブラシ２０は、駆動軸１５に対して位置決めされて、駆動軸１５の周方向に不用意に回ることがないように取付けられるものである。

【００１３】なお、図４に示すように歯ブラシ２０の往復の変位量Ｌは３～７mmに定められ、そのために、前記駆動ピン１４の従動平歯車１０の中心に対する偏心量ｌを1.5～ 3.5にしてある。また、図２に示すように本体ケース１の上端部外面には、柔軟性に富むゴムで形成された防水キャップ２３が、駆動軸１５の本体ケース１外に突出した部分をその周囲から覆って取付けられている。

【００１４】前記構成の電動歯ブラシのモータ６に通電して駆動機構３を動作させると、駆動歯車７の回転が、中間歯車８との噛み合いでこれと中間平歯車９に伝えられた後、この歯車９との噛み合いで従動平歯車１０に伝えられて、この歯車１０を回転させる。このため、駆動ピン１４が同時に前記偏心量ｌを半径とする偏心円運動を行いながら駆動軸１５の係合溝１６内を移動するから、これら駆動ピン１４と係合溝１６との係合を介して、駆動軸１５が軸方向に前記偏心量ｌの２倍の量を変位とする直線往復動を行う。なお、この駆動軸１５の往復動作は高速であって、毎分2000～3000回（１往復を１回とする）行われる。

【００１５】したがって、歯ブラシ２０全体がその軸方向に３～７mmのストロークで往復動される。このようにして高速で直線往復動される歯ブラシ２０のブラシ毛２２を歯等に軽く押し当てることにより、歯部をブラッシングできる。このブラッシングにおいて、防水キャップ２３はその柔軟性により可撓変形するので、容易に駆動軸１５の動きに追従でき、駆動軸１５の動作を妨げることがない。

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【００１６】そして、以上のように高速で往復動される駆動軸１５はすべり軸受１８で支持されているが、この軸受１８の軸受孔１９は四角形状であるので、この孔１９を貫通する駆動軸１５の断面円形の中間部分１５ｂは、図１に示すように軸受面１９ａに対して４か所で線接触している。

【００１７】そのため、すべり軸受１８と駆動軸１５との接触面積が小さく、この駆動軸１５の摺動抵抗を少なくできる。したがって、前記モータ６を駆動する電池４の消費電力を少なくできるとともに、この電池４の寿命を延ばすことができる。

【００１８】ちなみに、前記構成の電動歯ブラシに、電池４に単３形アルカリ電池を使用するとともに歯ブラシ２０を装着しこれに 300ｇの負荷を掛けた状態で連続運転した時の、運転時間に対する電池電圧の変化を測定した結果が、図５中Ｂに示されている。この比較試験によれば、軸受構造での負荷が小さいために使用開始時点での電池電圧が 1.4Ｖ強と大きく、実使用可能電圧（ 0.9Ｖ）に達するまでに約６３分の時間を費やし、従来の軸受構造を備えた電動歯ブラシに比較して、2.52倍の寿命向上を確認できた。このような寿命向上により、電池４の交換頻度（なお、電池４が蓄電池の場合には充電頻度）を少なくできる。

【００１９】また、図５中Ｂから明らかなように電池電圧の低下が少ないから、モータ６に与える電力も多く、よってモータ６のトルク、換言すれば歯ブラシ２０の駆動力も長時間にわたって大きく維持できる。その上、既述のように駆動軸１５の周方向の４か所が軸受面１９ａに接触しているので、軸受孔１９に対する駆動軸１５の嵌合精度が損なわれることがなく、したがって、駆動軸１５のすべり軸受１８に対するがたつきが大きくなって、騒音を高めるようなことがない。図６～図９は夫々異なる他の実施例の要部を示した前記図１相当の断面図であり、以下、前記第１実施例とは異なる部分についてのみ説明する。

【００２０】図６に示した第２実施例は、軸受孔１９の軸直角方向の断面を四角ではなく、長さが等しい三つの平面の端部同志を円弧面で繋いでなる軸受面１９ａで軸受孔１９を形成した構成である。このような軸受孔１９を有した軸受構造によれば、駆動軸１５の断面円形をなす中間部分１５ｂの外周３か所が軸受面１９ａに線接触するから、接触面積および駆動軸１５の摺動抵抗が夫々更に小さくなって、駆動軸１５を駆動するモータの消費電力をより少なくできる。

【００２１】図７に示した第３実施例は、すべり軸受１８の軸方向に延びるビード１９ｂを三つ以上軸受け面１９ａに突設して、これらビード１９ｂの丸まった先端ま

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たは凹面（図示しない）を駆動軸１５の断面円形をなす中間部分１５ｂに接触させて、駆動軸１５を支持した構成である。このような軸受構造においても、駆動軸１５の周方向数箇所がすべり軸受１８に線接触（または面接触）するから、駆動軸１５の摺動抵抗を小さくして、本発明の所期の目的を達成できる。

【００２２】図８に示した第４実施例は、すべり軸受１８の軸受孔１９を断面円形とするとともに、この軸受孔１９に嵌合する駆動軸１５の中間部分１５ｂの軸直角方向の断面を四角形状とし、かつ、前記中間部分１５ｂの四隅を夫々円弧面に形成して、これら円弧面を、軸受孔１９を作る軸受面１９ａに線接触ないしは面接触（これらの接触の仕方は前記四隅の円弧の曲率によって決まる。）させた構成である。そして、このような軸受構造においても、駆動軸１５の周方向の４か所が軸受面１９ａに接触するから、接触面積および駆動軸１５の摺動抵抗が夫々小さくなって、駆動軸１５を駆動するモータの消費電力をより少なくできる。

【００２３】図９に示した第５実施例は、すべり軸受１８の断面を四角状軸受孔１９に嵌合される駆動軸１５の中間部分１５ｂの軸直角方向の断面を四角形状とし、かつ、その四隅を夫々円弧面に形成して、これら円弧面を、前記軸受孔１９を作る軸受面１９ａに線接触させた構成である。そして、このような軸受構造においても、駆動軸１５の周方向の４か所が軸受面１９ａに線接触するから、接触面積および駆動軸１５の摺動抵抗が夫々小さくなって、駆動軸１５を駆動するモータの消費電力をより少なくできる。

【００２４】なお、本発明は前記各実施例に制約されず、本発明は電源にコードを介して商用交流電源を利用するタイプの電動歯ブラシにも実施できることはいうまでもなく、駆動機構の動力源として電磁的に振動を発生する電磁バイブレータを用いてもよいとともに、駆動軸（可動軸）の往復動は軸方向ではなく周方向に往復動させるものでも良い。また、本発明は往復動されるプランジャを有し、このプランジャの先端に取付けた叩打子を、使用者の患部に打ち当てるプランジャタイプの電動マッサージャ等にも適用できる。さらに、すべり軸受１８は本体ケース１と一体に成形しても良い。

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【００２５】

【発明の効果】以上詳記したように本発明の電動歯ブラシ等に使用される軸受構造においては、軸受孔に対する可動軸の嵌合精度が損なわれることがないとともに、軸受孔に対する可動軸の摺動抵抗を小さくして、動力源を駆動する電源の消費電力を少なくできるという効果がある。

【図面の簡単な説明】

【図１】本発明の第１実施例に係り図２中Ｚ－Ｚ線に沿って軸受構造を示す断面図。

【図２】同第１実施例に係り電動歯ブラシの全体を示す縦断側面図。

【図３】同第１実施例に係り電動歯ブラシの駆動機構を示す斜視図。

【図４】同第１実施例に係り駆動機構による歯ブラシの往復動の原理を示す図。

【図５】電動歯ブラシの運転時間と電池電圧との関係を示す図。

【図６】本発明の第２実施例に係る軸受構造を示す断面図。

【図７】本発明の第３実施例に係る軸受構造を示す断面図。

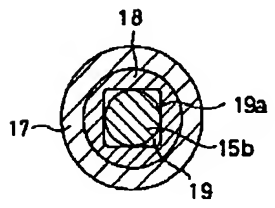
【図８】本発明の第４実施例に係る軸受構造を示す断面図。

【図９】本発明の第５実施例に係る軸受構造を示す断面図。

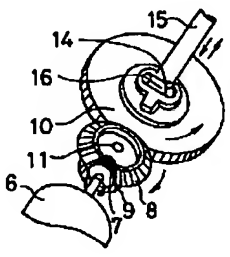
【符号の説明】

６…モータ（動力源）、１６…駆動軸（可動軸）、１６ｂ…駆動軸の中間部分（孔嵌合部分）、１８…すべり軸受、１９…軸受孔、１９ａ…軸受面。

【図１】



【図３】



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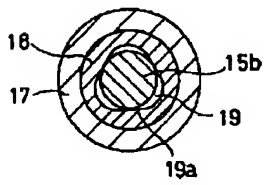

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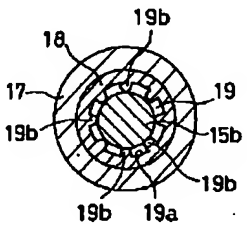

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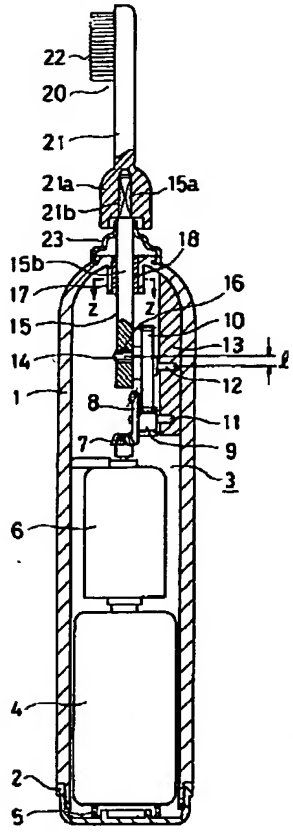
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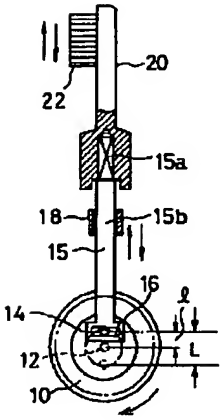
20
21
21a
21b
23
15b
17
15
14
1
8
7
6
4
2
5
15a
18
16
10
13
12
11
9
3
Z
Z
ℓ

【図4】


22
20
15a
18
15b
15
16
14
12
10
ℓ
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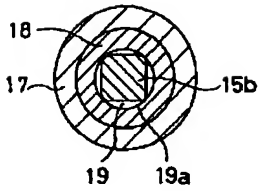
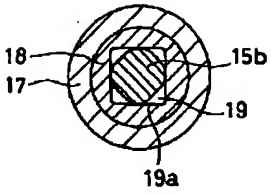
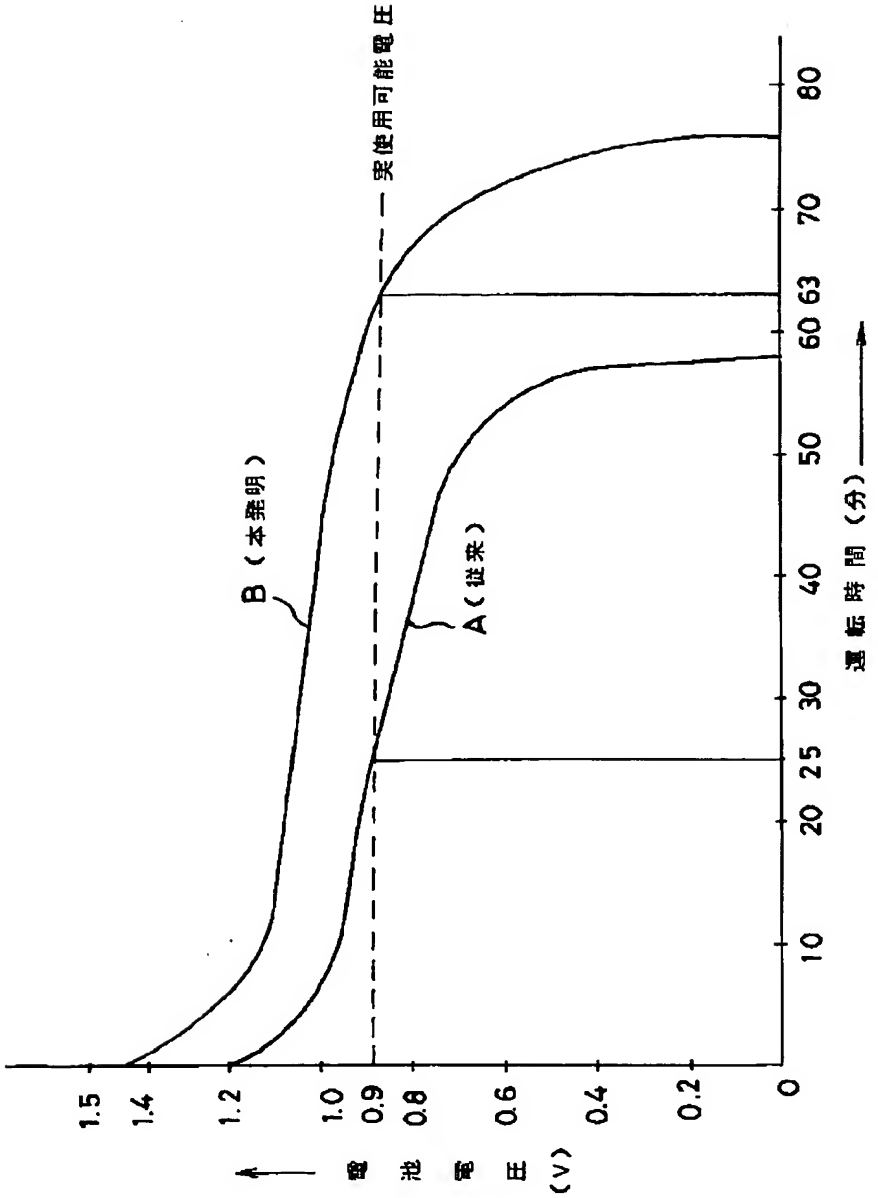

18
17
15b
19
19a

【図9】


18
17
15b
19
19a

【図5】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A（従来）
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0.8
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0.2
0
10
20
25
30
40
50
60
63
70
80
運転時間（分）

Japanese Kokai Patent Application No. Hei 5[1993]-95816

Job No.: 778-91327 Ref.: JP405095816
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BEARING STRUCTURE USED IN AN ELECTRIC TOOTHBRUSH AND THE LIKE

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[There are no amendments to this patent.]

Abstract

Purpose

The purpose of this invention is to obtain a bearing structure for use in an electric toothbrush and the like, wherein the electricity consumption from a power source that drives the motor is reduced.

Structure

The cross section in the direction orthogonal to the shaft of a bearing hole (19) of a slide bearing (18) that supports a driving shaft (15) reciprocated by the power of a motor (6), and/or the intermediate section (15b) of the aforementioned driving shaft (15) that fits into this bearing hole (19), is formed in a non-circular shape, and the bearing surface (19a) formed by the aforementioned bearing hole (19) of the aforementioned slide bearing (18), makes contact at several locations in the circumferential direction with a part (15b) of the aforementioned driving shaft (15) that fits in the hole.

Claim

1. A bearing structure, used in an electric toothbrush and the like, wherein a movable shaft, which reciprocates in the direction of the shaft or in the circumferential direction, is supported by a slide bearing, characterized in that the cross section in the direction orthogonal to the shaft of a bearing hole of the aforementioned slide bearing, and/or the part of the aforementioned movable shaft that fits into this bearing hole, are/is formed into a non-circular shape, and the bearing surface formed by the aforementioned bearing hole of the aforementioned slide bearing makes contact with the part of the aforementioned movable shaft that fits in the hole at several locations in the circumferential direction.

Detailed explanation of the invention

[0001]

Industrial application field

This invention concerns a bearing structure that is used, for example, in an electric toothbrush for brushing teeth, and by which the consumption of electricity is reduced.

[0002]

Prior art

An electric toothbrush houses a motor as a power source, and a driving mechanism, which receives this power, within a cylindrically shaped main case. These operate a toothbrush, attached in a freely attachable and detachable manner to the driving shaft, that projects from the top end of the main case. This is used for brushing teeth by means of a reciprocating linear motion in the direction of the shaft or a reciprocating circular motion in the circumferential direction of the toothbrush, at high speed, together with the driving shaft of the aforementioned driving mechanism.

[0003]

The driving shaft (movable shaft) that is reciprocated by the power of the motor, as described above, is supported by a slide bearing at 1-2 locations. Conventionally, the cross-section of the bearing hole of the slide bearing in the direction orthogonal to the shaft was circular, and the cross-section of the driving shaft that fits into this bearing hole, in the direction orthogonal to the shaft, was also circular, and the driving shaft reciprocated while slidingly contacting the bearing surface of the bearing hole of the slide bearing with its outer circumferential surface.

[0004]

Problem to be solved by the invention

In the aforementioned conventional bearing structure, the contact area between the driving shaft and the bearing surface for the driving shaft was large, making, the sliding resistance to the driving shaft large, and the concomitant high power consumption became an issue. As a result, the battery life is short when using dry cell batteries as the power source of the motor. As a reference, Figure 5A shows the results of measuring the change in battery voltage over time for a conventional electric toothbrush that uses AAA alkaline batteries as a power source (where the driving shaft is stainless steel, the slide bearing is made from polyacetal resin, and the driving shaft has a linear reciprocating motion) and continuously operating this with toothbrush attached and with a 300 g load applied. It is acknowledged that the battery voltage is low at 1.2 V, at the beginning of use because the bearing structure load is high, and the actual usable voltage (a battery voltage of 0.9V, below which sufficient driving force cannot be supplied to the driving shaft) is reached quickly, in about 25 min. The purpose of this invention is to obtain a bearing structure for use in an electric toothbrush, for example, in which the electrical power consumption from the power source is reduced.

[0005]

Means to solve the problem

In achieving the aforementioned purpose, the bearing structure of this invention, used in an electric toothbrush, for example, is characterized in that the cross section, in the direction orthogonal to the shaft, of a bearing hole of a slide bearing that supports a driving shaft reciprocated by a power source in the direction of the shaft or in the direction of the circumference, or the part of the aforementioned movable shaft that fits in the hole that fits into this bearing hole, is formed in a non-circular shape, and the bearing surface, formed by the aforementioned bearing hole of the aforementioned slide bearing, makes contact with a part of

the aforementioned movable shaft that fits in the hole at several locations in the circumferential direction.

[0006]

Function

In the aforementioned structure, the cross section of at least either the bearing hole of the slide bearing or the part of the movable shaft that fits in the hole is formed in a non-circular shape, so that the bearing surface of the slide bearing and the aforementioned part that fits in the hole make contact at several locations in the circumferential direction. As a result, the accuracy of the fit between the movable shaft and the bearing hole is not lost, and the contact area between the bearing hole and the movable shaft is made small, so that the sliding resistance of the movable shaft can be reduced.

[0007]

Application examples

Application Example 1 of this invention will be explained by referring to Figures 1-5 below.

[0008]

In Figure 2, (1) is a main case made of a resin forming a cylindrical shape having a thickness and length that can be firmly held by one's hand, and an opening at the lower end is closed by a lid (2) that is screwed on in an attachable and detachable manner. A driving mechanism (3) is housed in this main case (1), and a battery (4), that is used as a power source for this mechanism (3) is also housed. Dry cell batteries or rechargeable batteries are used as the battery (4). A dry cell battery that is inserted and removed by opening and closing the aforementioned lid (2) is used in this application example. In Figure 2, (5) indicates a spring that pushes against the battery.

[0009]

The driving mechanism (3) has the structure indicated in Figures 2 and 3. More precisely, (6) is a motor as a driving means that is operated when electrical power from the battery (5) is applied, and a driving gear (7) is attached to its output shaft. An intermediate [bevel] gear (8) engages with this gear (7), and an intermediate spur gear (9) is attached to this gear (8). A coupled spur gear (10) engages with the intermediate spur gear (9). (11) and (12) in Figures 2-4 are respective gear shafts, the gear shaft (11) supporting the aforementioned gears (8) and (9), and the gear shaft (12) supporting the aforementioned gear (10). These gear shafts (11) and (12)

are supported by a gear base (13) that is fixed to the inner surface of the main case (1). Furthermore, a driving pin (14) projects from the coupled spur gear (10) at an eccentric position relative to the center.

[0010]

A driving shaft (15) is attached as a movable shaft to this driving mechanism (3) by engaging with the driving pin (14). More precisely, a long horizontal engagement groove (16) is provided to a stainless steel driving shaft (15) in the direction orthogonal to the shaft, for example, and driving pin (14) is inserted into and engages with this groove (16). The driving shaft (15) projects out from the upper end of the main case (1) through a cylindrical bearing supporting part (17) that is formed at the upper end of the main case (1). A square shaft part (15a) with a square cross-section in the direction orthogonal to the shaft is formed at the tip area of this driving shaft (15) projecting outside of the main case (1). The middle section (15b) of the driving shaft (15), except for the lower end where the aforementioned engagement groove (6) is provided and the square shaft part (15a) at the upper tip, is formed of a round bar with a circular cross section, as shown in Figure 1.

[0011]

A slide bearing (18) is housed within the aforementioned bearing supporting part (17), and the driving shaft (15) passes through this bearing (18). The slide bearing (18) is an integrally molded product made of a polyacetal resin, and it has a bearing hole (19) in the center that is open at its upper and lower ends, as shown in Figure 1. This bearing hole (19) is formed, in the direction orthogonal to the shaft, with a non-circular cross section such as a near-quadrilateral shape, for example. The middle section (15b) with a circular cross section of the driving shaft (15) (in other words, the part that fits in the hole) is the fitted into this bearing hole (19). As a result, the circumferential surface of the aforementioned middle section (15b) comes into contact with the bearing surface (19a) of the slide bearing (18), in which is formed the bearing hole (19), at 4 locations, and the driving shaft (15) is supported by the slide bearing (18) in a freely slideable manner.

[0012]

As shown in Figure 2, a toothbrush (20) is attached to the square shaft part (15a) of the driving shaft (15) in a freely attachable and detachable manner. Toothbrush bristles (22) are implanted at the tip of a handle (21) of the toothbrush (20), and a fitting part (21b), consisting of a hole, for example, in the base (21a) of the handle (21), is formed to fit onto the top end of the square shaft part (15a) in an attachable and detachable manner. The toothbrush (20) is positioned

to the driving shaft (15) when the fitting part (21b) fits onto the square shaft part (15ba) [sic; (15a)], and it is attached so that it does not rotate unnecessarily in the circumferential direction of the driving shaft (15).

[0013]

As shown in Figure 4, the amount of displacement L during reciprocation of the toothbrush (20) is designed to be 3-7 mm, and the amount of eccentricity *l* of the aforementioned driving pin (14) relative to the center of the coupled spur gear (10) is accordingly set to 1.5-3.5. As shown in Figure 2, a water-proof cap (23) formed of a highly-flexible rubber is attached to the outer surface of the upper end of the main case (1) to cover from the periphery the area where the driving shaft (15), projects outside the main case (1).

[0014]

When the driving mechanism (3) is operated by sending electricity to the motor (6) of an electric toothbrush with the above-described structure, rotation of the driving gear (7), is transmitted to the coupled middle gear (8) and to the middle spur gear (9), and is then transmitted to the coupled spur gear (10) by engagement with gear (9), causing gear (10) to rotate. As a result, the driving pin (14) at the same time follows a circular path with the aforementioned eccentric amount *l* as the radius, and moves inside the engagement groove (16) of the driving shaft (15). The driving shaft (15) therefore has a linear reciprocating motion, wherein it is displaced 1-2 times the amount of the aforementioned eccentric amount *l* in the direction of the shaft by virtue of the engagement between driving pin (14) and engagement groove (16). This driving shaft (15) reciprocates at the high speed of 2000-3000 times per min(1 reciprocation being counted as 1 time).

[0015]

Accordingly, the entire toothbrush (20) reciprocates with a stroke of 3-7 mm in the direction of the shaft. By lightly pressing the toothbrush bristles (22) of the toothbrush (20) with this high-speed linear reciprocating motion against the teeth, for example, the teeth can be brushed. During this brushing, the waterproof cap (23) flexibly changes its shape by virtue of its flexibility, and it can easily follow the movement of the driving shaft (15) without impeding the movement of the driving shaft (15).

[0016]

During this, the driving shaft (15), which has the high-speed reciprocating motion described above, is supported by the slide bearing (18). The shape of the bearing hole (19) of this

bearing (18) is a square, so that the middle part (15b) with a circular cross-section of the driving shaft (15) passes through this hole (19) and makes a linear contact with the bearing surface (19a) at 4 locations, as is shown in Figure 1.

[0017]

As a result, the contact area between the slide bearing (18) and the driving shaft (15) is small, and the sliding resistance with this driving shaft (15) can be made small. Accordingly, the consumption of electricity from the battery (4) that drives the aforementioned motor (6) can be made small, and the life of this battery (4) can be extended.

[0018]

For reference, Figure 5B shows the results of measuring the change in battery voltage over time for an electric toothbrush with the aforementioned structure in continuous operation, using a AAA alkaline battery as the battery (4) and with toothbrush (20) attached and a 300 g load applied. In this comparison test, the battery voltage at the starting point of use is high, at 1.4V, because the load from the bearing structure is small, and about 63 min elapse before the actual usable voltage (0.9 V) is reached. When compared to an electric toothbrush equipped with a conventional bearing structure, an improvement in working life of 2.52 times is confirmed. Such an improvement in the working life means that the frequency of replacing battery (4) (of the frequency of recharging battery (4) when using a rechargeable battery) can be reduced.

[0019]

As is clearly shown in Figure 5B, the battery voltage decrease is small, so that the power delivered to the motor (6) is large. Accordingly, a high torque can be maintained from motor (6), or in other words, a high driving power of the toothbrush (20) can be maintained for a long time. Moreover, the driving shaft (15) comes into contact with the bearing surface (19a) at 4 locations in the circumferential direction, as described above, so that the accuracy of the fit of the driving shaft (15) with the bearing hole (19) is not lost. Accordingly, the noise does not increase when the offset of the driving shaft (15) from the bearing surface (18) increases. Figures 6-9, respectively, show cross-sectional diagrams equivalent to the aforementioned Figure 1 showing the chief part of different application examples. Only parts that are different from the aforementioned Application Example 1 will be explained.

[0020]

Application Example 2 indicated in Figure 6 has a structure wherein the cross-section of the bearing hole (19) in the direction orthogonal to the shaft is not a square, but the bearing hole

(19) is formed with a bearing surface (19a), wherein the ends of 3 flat surfaces of equal length are connected by circular surfaces. By means of a bearing structure with such a bearing hole (19), 3 parts of the outer circumference of the middle section (15b), which has a circular cross section, of the bearing shaft (15) have a linear contact with the bearing surface (19a). Therefore, the contact area and the sliding resistance of the driving shaft (15) are respectively further reduced, and the electricity consumption of the motor that drives the driving shaft (15) can be further reduced.

[0021]

Application Example 3, shown in Figure 7, has a structure in which 3 or more beads (19b), extending in the direction of the shaft, of slide bearing (18) project from the bearing surface (19a), and the rounded end or the recessed surface (not shown in the diagram) of these beads (19b) makes contact with the middle section (15b) having a circular cross-section of the driving shaft (15), and supports the driving shaft (15). In such a bearing mechanism, the driving shaft (15) still has a linear contact (or a surface contact) with the slide bearing (18) at several locations in the circumferential direction, and the sliding resistance of the driving shaft (15) can be made small, and the intended purpose of this invention can be attained.

[0022]

Application Example 4, shown in Figure 8, has a structure in which the bearing hole (19) of the slide bearing (18) is formed with a circular cross-section, the cross-section in the direction orthogonal to the shaft of the middle section (15b) of the driving shaft (15), which fits into this bearing hole (19), is formed in the shape of a square, the 4 corners of the aforementioned middle section (15b) are respectively formed as circular surfaces, and these circular surfaces make linear or surface contact (depending on the curvature at the aforementioned 4 corners) with the bearing surface (19a) formed by the bearing hole (19). In this bearing structure as well, 4 parts of the driving shaft (15) in the circumferential direction make contact with the bearing surface (19a), the contact area and the sliding resistance of the driving shaft (15) are respectively made small, and the electricity consumption of the motor that drives the driving shaft (15) can be further reduced.

[0023]

Application Example 5, shown in Figure 9, shows a structure in which the cross-section of the slide bearing (18), and the cross-section of the middle section (15b) of the driving shaft (15) that fits into the quadrilateral bearing hole (19), are respectively formed in quadrilateral shapes in the direction orthogonal to the shaft, 4 corners are also respectively formed as circular

surfaces, and these circular surfaces make linear contact with the bearing surface (19a) formed by the aforementioned bearing hole (19). In such a bearing structure, the driving shaft (15) also has a linear contact with the bearing surface (19a) at 4 locations in the circumferential direction, so that the contact area and the sliding resistance of the driving shaft (15) are respectively reduced, and the electricity consumption of the motor that drives the driving shaft (15) is further reduced.

[0024]

This invention should not, however, be limited by each of the aforementioned application examples, and this invention can certainly be applied to types of electric toothbrushes that connect with a cord to a commercial ac power source. The driving mechanism can also be powered by an electromagnetic vibrator, and the reciprocating motion of the driving shaft (movable shaft) can be a reciprocating motion in the circumferential direction instead of the direction of the shaft. This invention can also be applied to a plunger type of electric massager, for example, that is equipped with a plunger that reciprocates and a hitting part, attached to the tip of this plunger, that hits the user's affected area, for example. Furthermore, the slide bearing (18) can be integrally molded together with the main case (1).

[0025]

Effect of the invention

As explained in detail above, in the bearing structure used in an electric toothbrush in this invention, for example, the accuracy of the fit of the movable shaft with the bearing hole is not lost, the sliding resistance of the movable shaft in the bearing hole can be made small, and the electricity consumption from the power source that drives the device can be reduced.

Brief description of the figures

Figure 1 is a cross-sectional diagram showing the bearing structure, along line Z-Z in Figure 2,in Application Example 1 of this invention.

Figure 2 is a side view vertical section showing the entire electric toothbrush in Application Example 1 of this invention.

Figure 3 is an oblique view showing the driving mechanism of the electric toothbrush in Application Example 1 of this invention.

Figure 4 is a diagram showing the principle of the reciprocating motion of a toothbrush caused by the driving mechanism in Application Example 1 of this invention.

Figure 5 is a diagram showing the relationship between the length of operation of the electric toothbrush and the battery voltage.

Figure 6 is a cross section showing the bearing mechanism in Application Example 2 of this invention.

Figure 7 is a cross section showing the bearing mechanism in Application Example 3 of this invention.

Figure 8 is a cross section showing the bearing mechanism in Application Example 4 of this invention.

Figure 9 is a cross section showing the bearing mechanism in Application Example 5 of this invention.

Explanation of the numbers

6 ...Motor (power source); 16 ...Driving shaft (movable shaft); 16b ...Middle section of the driving shaft (part that fits in the hole); 18 ...Slide bearing; 19 ...Bearing hole; and 19a ...Bearing surface.

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Key: 1 Battery voltage (V)
2 Operational time (min)
3 B (This invention)
4 A (Conventional)
5 Actual usable voltage

Figure 6

Figure 7

Figure 8

Figure 9